

SYSTEM AND METHOD FOR SUPPLYING POWER TO A POWER AMPLIFIER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit under 35 U.S.C. §120 as a continuation of U.S. patent application Ser. No. 14/975,068, titled “POWER SUPPLY,” filed on Dec. 18, 2015, which is a continuation of U.S. patent application Ser. No. 14/208,553, titled “POWER SUPPLY,” filed on Mar. 13, 2014, now U.S. Pat. No. 9,225,362, which claims priority under 35 U.S.C. §119(e) to U.S. Provisional Patent Application Ser. No. 61/785,588, titled “POWER SUPPLY,” filed on Mar. 14, 2013, each of which is hereby incorporated herein by reference in its entirety.

BACKGROUND

[0002] 1. Field of the Disclosure

[0003] This application relates to power supplies, and more specifically to power supplies for envelope tracking power amplifier systems.

[0004] 2. Description of the Related Art

[0005] Mobile devices communicate using a variety of wireless technologies, some of which use radio frequency (RF) power amplifier (PA) systems with envelope tracking power supplies to transmit wireless signals. Mobile devices also have batteries that provide a source of power for the RF PA system. However, the battery is a limited source of power. Thus, it is preferable for the power supply of the RF PA system to be power efficient. Additionally, the battery voltage can droop due to power demands from other circuits in the mobile device. The variance in the battery voltage can degrade the signal integrity of the RF PA system.

SUMMARY

[0006] Embodiments of the present disclosure include a power supply for a radio frequency (RF) power amplifier that amplifies an RF input signal into an RF output signal. The power supply comprises a first power converter to convert an input voltage to the power supply into a first supply voltage of the RF power amplifier. The power supply comprises a second power converter to receive the input voltage and the first supply voltage and to selectively convert either the input voltage or the first supply voltage into at least a portion of a second supply voltage of the RF power amplifier.

[0007] In one embodiment, the power supply further comprises a control circuit to generate a supply control signal for the second power converter based on an amplitude signal indicative of an amplitude of the RF input signal. The second power converter controls a level of the portion of the second supply voltage of the RF power amplifier based on the supply control signal. In another embodiment, the second power converter further selects either the input voltage or the first supply voltage for conversion based on a level of the input voltage to the power supply.

[0008] In another embodiment, the second power converter selectively converts either the input voltage or the first supply voltage into a first output voltage. A third power converter to receive the input voltage and to convert the input voltage into a second output voltage. A power com-

biner circuit to combine the first output voltage and the second output voltage into the second supply voltage of the RF power amplifier.

[0009] Embodiments of the preset disclosure includes a method of operation in the power supply. The method comprises converting, by a first power converter, an input voltage to the power supply into a first supply voltage of the RF power amplifier. The method further comprises selectively converting, by a first power converter, either the input voltage to the power supply or the first supply voltage of the RF power amplifier into at least a portion of a second supply voltage of the RF power amplifier.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The teachings of the embodiments disclosed herein can be readily understood by considering the following detailed description in conjunction with the accompanying drawings.

[0011] FIG. 1 is a RF PA system with an envelope tracking power supply, according to an embodiment.

[0012] FIG. 1A is a buck converter from FIG. 1, according to an embodiment.

[0013] FIG. 1B is a power combiner circuit from FIG. 1, according to an embodiment.

[0014] FIG. 2 is a RF PA system powered by an envelope tracking power supply during an envelope tracking mode of operation, according to an embodiment.

[0015] FIG. 3 is a RF PA system powered by an envelope tracking power supply during another envelope tracking mode of operation, according to an embodiment.

[0016] FIG. 4 is a RF PA system powered by an envelope tracking power supply during an average power tracking mode of operation, according to an embodiment.

[0017] FIG. 5 is a RF PA system powered by an envelope tracking power supply during another average power tracking mode of operation, according to an embodiment.

[0018] FIG. 6 is a RF PA system powered by an envelope tracking power supply, according to another embodiment.

DETAILED DESCRIPTION

[0019] Reference will now be made in detail to several embodiments, examples of which are illustrated in the accompanying figures. It is noted that wherever practicable similar or like reference numbers may be used in the figures and may indicate similar or like functionality. The figures and accompanying description depict various embodiments for purposes of illustration only. One skilled in the art will readily recognize from the following description that alternative embodiments of the structures and methods illustrated herein may be employed without departing from the principles described herein. As used herein, the terms “estimating” “determining” or “computing” may be used interchangeably with each other.

[0020] An ultra fast power supply architecture is disclosed. Its primary use is as an envelope tracking (ET) power supply in an envelope tracking (ET) power amplifier (PA) system. The power supply comprises two switching power converters (e.g., one buck/boost, one buck) and a linear power converter. The combination of the two switching power converters and linear power converter enables the power supply to maintain output power regulation for two power rails even when a battery input voltage droops. The combination of power converters also increases the flexibil-